OREGON DEPARTMENT OF AGRICULTURE

UNITED STATES FOREST SERVICE

Pest Risk Assessment of *Alyssum murale* and *A. corsicum*

Prepared by Kelly Amsberry (ODA), Maureen Jules (USFS) and Robert J. Meinke (ODA)

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Identity: *Alyssum murale* and *Alyssum corsicum*

Family: Brassicaeae

Common name: yellowtuft

Introduction

Phytomining

Promoted as an environmentally conscious method for cleaning up contaminated mining sites, phytoremediation consists of planting hyperaccumulators (plants with the ability to extract metals from the soil and concentrate them in stems, shoots and leaves) on mine wastes. Once plants are mature, they are harvested and burned. The metallic ash is processed to produce usable metals, and the concentrations of toxic elements in the contaminated soils eventually decrease. *Alyssum murale* (Brassicaceae), a native of eastern European serpentine soils, is one of the most studied of these hyperaccumulator plants (Figure 1). This perennial, yellow-flowered mustard has been used successfully in several locations in Canada to reduce toxic levels of nickel from mine waste, while also providing a source of ore for a nearby smelter (Strauss 2002).

Figure 1. A specimen of *A. murale* in flower at the Seats Dam site in 2007. (Photo by K. Amsberry.)

In the late 1990's, the proposed uses of *Alyssum murale* were expanded to include not only phytoremediation (decontamination of mine wastes), but phytomining, the removal of metals from naturally occurring mineral soils. Oregon State University Extension Service evaluated use of this plant as a new farm crop in 2002, and indicated that neither *A. murale* nor the related

A. corsicum had to potential to spread "across the serpentine landscape in an uncontrolled manner." (Roseburg 2003). Based on this assessment, the risk of this exotic species invading natural areas and outcompeting native species was deemed minimal, and planning for cultivation of the new crop continued. The following year, Texas-based Viridian Resources sowed *A. murale* and *A. corsicum* seed at several serpentine sites in Josephine County, including fields located immediately adjacent to the floristically diverse Rough and Ready Botanical Area, and managed by the Illinois Valley Airport.

The Illinois Valley

The Illinois Valley contains the greatest concentration of serpentine soils in Oregon, and supports a diverse and unique flora. Fifteen plant taxa with conservation status (listed as rare, threatened or endangered by Oregon Department of Agriculture, U.S. Fish and Wildlife Service or Oregon Natural Heritage Information Center) occur in this area, including two species federally listed as endangered (Figure 2). Several additional species, although rare, have not required conservation status due to the lack of documented threats to their viability. The unsuitability of the harsh serpentine habitat to farming and development - *and the resistance of these areas to weed invasions* - has allowed these rare edaphic endemics present to flourish undisturbed. The beauty and uniqueness of the Illinois Valley flora ranks with that of other serpentine based biodiversity "hotspots" throughout the world (such as those in New Caledonia, South Africa, Cuba and California), and the potential contribution of these

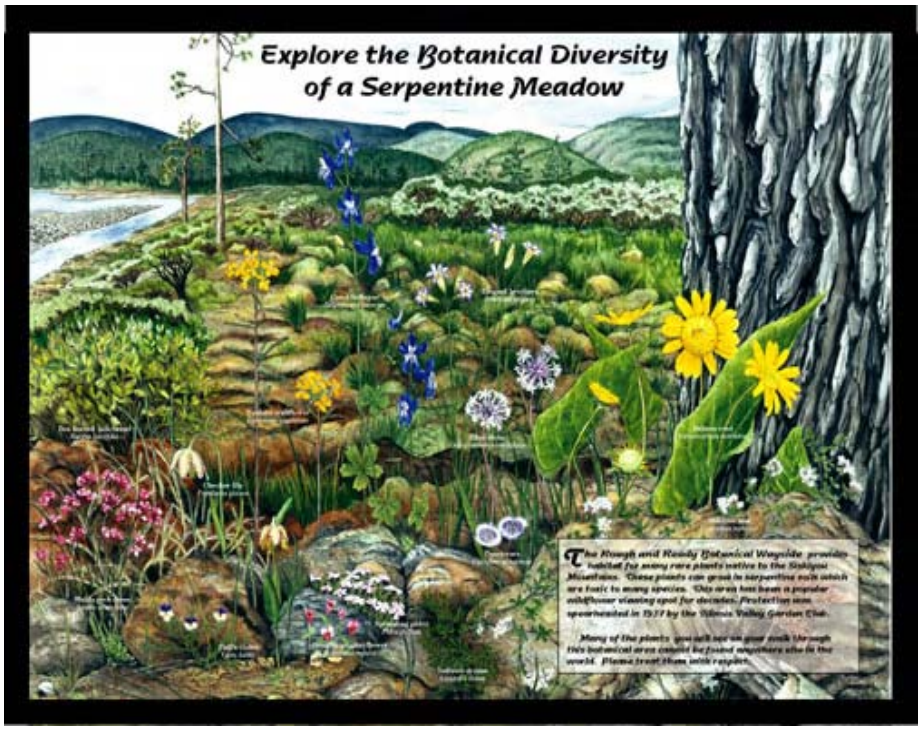

Figure 2. A depiction of Rough and Ready Botanical Area by Oregon artist Paula Fong. This poster is sold at local gift shops in Josephine County.

wildflower areas to tourism are recognized by local tourism promoters (http://www.southernoregon.org/cities/illinoisvalley.html, http://www.cavejunction.com/cavejunction/areainfo.shtml, http://www.stagestopdrive.com/area.asp).

Cultivation and spread

Despite Viridian's statements in Josephine County's lease agreement for the County-managed airport site that plants would be harvested prior to flowering (thus preventing seed dispersal), harvest did not occur as scheduled, and the cultivated airport fields were soon covered with a sea of bright yellow flowers. By 2005, local citizens reported observing *A. murale* far from cultivated fields, and land managers were becoming skeptical of early assertions regarding the inability of this species to invade Josephine County's botanically rich serpentine areas. Harvested and baled plants continued to release seed during storage and transport, and neighboring landowners documented spread beyond field boundaries. Evaluation by an interagency task force began in 2005, and by 2008 reproductive plants were documented at eight locations distant from cultivated plots. Masses of flowering plants were also observed along access roads adjacent to farmed fields, and unwanted plants proved difficult to eliminate.

Bales of harvested plants have remained piled at the airport site since 2005, with additional bales added, but no indication that transport and processing of the crop is occurring. The acreage currently planted with *Alyssum* is not known, although nine planted sites have been located, most with documentation of spread beyond field boundaries. Attempts by The Nature Conservancy to remove existing plants after purchase of a site previously planted with both species have not been successful, and this summer's herbicide treatment of the airport site also resulted in low mortality.

Growth Characteristics

In their native habitat, plants of *Alyssum murale* grow to 0.5 – 0.75 meter in height, with multiple woody stems emerging from a stout caudex (Dudley 1965). However, escaped and cultivated plants of this species in the Illinois Valley are considerably larger, and may reach one meter or more in height (Figure 3). The gray-green oval or spatula-shaped (wide at the top and narrower at the bottom) leaves of *A. murale* are 0.5-1.0 cm long and are covered with tiny stellate hairs. *A. corsicum* is very similar, although the leaves of this species are more oval in shape and have a dense covering of silvery hairs, giving them a pale gray or white appearance. Plants of both species produce hundreds of small, bright yellow flowers on branched umbels (corymbs) in early summer. Because most leaves

are shed prior to the initiation of flowering, the two species look almost identical when in flower. No native plants are similar to either *Alyssum* species once flowering has begun, allowing for fairly reliable identification of cultivated and escaped mature plants in the field. Plants are fast growing perennials, reaching reproductive maturity within one or two years, and appear to be fairly long-lived, as large plants at the airport site have been producing seed for three consecutive years.

Reproduction, Survival and Dispersal

The showy flower clusters of both *Alyssum* species attract numerous insects. Although both species are reported to exhibit "low seed set" and be self-incompatible (McKenna et al. 2002), seed set on escaped plants in the Illinois Valley - even those occurring as single isolated individuals - is high. Both species produce the papery, circular to oval flattened fruits (silicles), each with a single flattened seed, that are typical of the genus. Hundreds of seeds are produced by each plant, and germination in the field is prolific. Seeds shed from baled plants as they were transported from satellite locations within the Illinois Valley to the Airport for processing are also viable, and their ability to germinate and grow under harsh conditions has allowed for the development of several roadside populations (Figure 4).

Figure 3. Plant of *A. murale* pulled from the Seats Dam site in 2007. (Photo by K. Amsberry.)

Seeds also germinate and grow well under controlled conditions. In November 2007, seed collected in summer of 2007 from mature plants near the Illinois Valley Airport was tested for viability at Oregon State University (OSU). Seeds were planted on serpentine soils collected from the Rough and Ready Botanical Area, as well as standard greenhouse potting mix. In the greenhouse, 60% of the seed planted on native soil emerged within one week - interestingly 85% of seed planted on potting mix also germinated (Figure 5). However, six months later, plants on serpentine soil were much more vigorous, with some starting to produce flowers. Germination also occurred in unheated flats in the nursery yard, although at lower rates. This study corroborates the results of earlier research demonstrating high survival rates (92% survival) for *A. murale* seedlings planted on nickel rich soils under field conditions

Figure 4. An *A. murale* population found at the base of the Lone Mt./Wimer road in 2008. This population consisted of 198 seedlings and 21 flowering plants - all were removed after documentation. The road is a primary access route onto the Josephine ophiolite shield (one of the largest and most botanically unique masses of serpentine bedrock in North America). (Photo by K. French.)

(Pendergrass and McKenna 2006). Initial crop development research on *A. murale* also documented easy seed germination, vigorous growth of seedlings and mature plants, and high tolerance of drought (Chaney et al. 2003a).

Although the dispersal mechanisms characteristic of *A. murale* in its native habitat are not known, fruits of this species are papery and fairly light, and can be easily blown by wind. In addition, portions of corymb with attached fruits easily break away from the mature plant, and these dry "mini-tumbleweeds" are also readily dispersed by wind.

Figure 5. All four seeds planted in this pot of soil collected from the Illinois Valley emerged vigorously within a few days of planting. The overall emergence for this treatment was 60%; n = 9. Inset shows plant after three weeks. (Photos by M. Carr.)

Seeds that have been released from their papery covering, and those with the covering intact, float on water (Figure 6), indicating that wind/and or water may be responsible for the non-human mediated dispersal observed in the Illinois Valley.

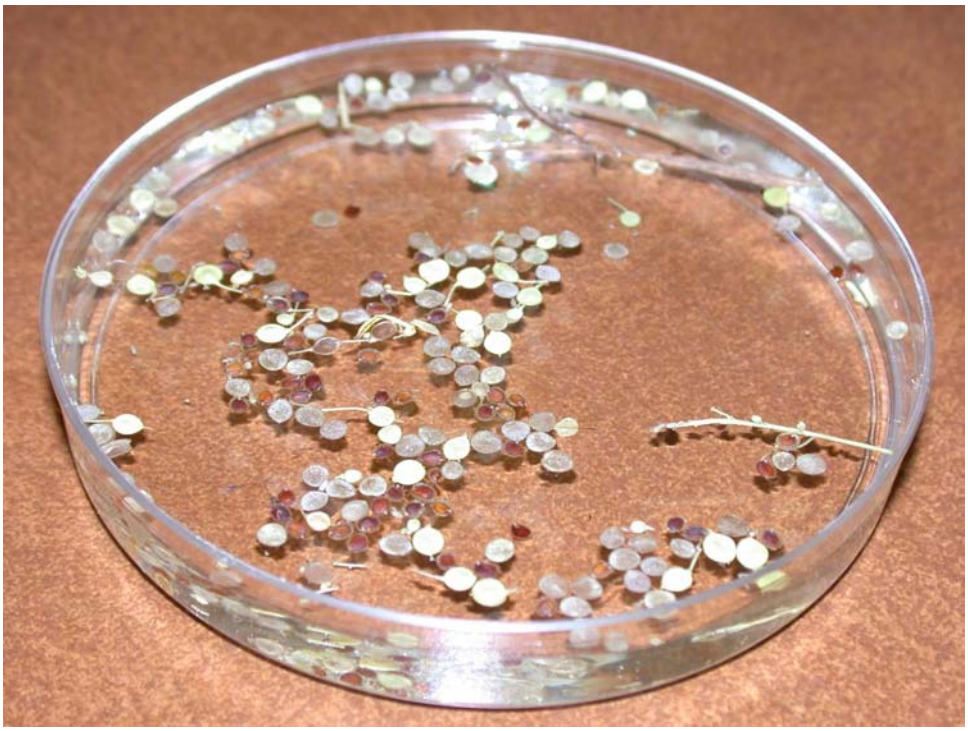

Figure 6. Seeds and fruits floating in water in a Petri dish in the lab. Seeds continued to float for more than 24 hours until the dish was discarded. Many seeds had begun to germinate vigorously (while floating) by that time. (Photo by K. Amsberry.)

Native Distribution

Alyssum murale is a widespread species found on serpentine soils throughout central and southern Europe (Dudley 1965). It is a well-represented component of the serpentine flora in this area, and is frequently documented from "waste areas," indicating its tolerance of harsh conditions. This species is very variable, exhibiting high levels of genetic variation (Mengoni et al. 2003), as well as subspecific morphological variation recognized by traditional taxonomy (Duldley 1965). *A. corsicum* has a more restricted range, occurring only in Turkey and Corsica, with the Corsican population theorized to have been transported from Turkey by humans (Mengoni et al. 2003).

Breeding agricultural cultivars of these two species has been a priority for development of *Alyssum* species for phytomining (2003b). Inclusion of diverse germplasm from throughout the species range was proposed as a component of the development of *Alyssum* for use in the Illinois Valley and

elsewhere, and several cultivars currently exist. Genetic engineering has been proposed as a component of continuing crop development, and patents for phytoming, including development and use of genetically modified strains of *Alyssum murale*, have been applied for http://www.freepatentsonline.com/EP0993510.html). The source and genetics of plants used in the Illinois Valley plantings is not known.

Infestations in North America

Escaped plants

Plants of *Alyssum murale* outside of cultivated fields were first discovered in Oregon in 2006 on U. S. Forest Service land by botanical technicians working for Wild Rivers Ranger District on the Rogue River-Siskiyou National Forest. Following the discovery of two separate infestations, the Wild Rivers District Botanist began formally tracking and removing plants on public land (Table 1). To date, a total of 404 plants have been removed from land administered by the USFS, BLM, State and ODOT (113 flowering plants, 291 non-flowering plants). More escaped *Alyssum* may be going undetected due to a lack of surveys and a lack of knowledge of other *Alyssum* plantings near public land.

Despite a lack of intensive surveys, each year new *Alyssum* infestations have been detected. In 2008, three days of surveys resulted in the discovery of five new sites, and documented increasing plant counts at known sites (Table 1; Figures 7-9). The infestation at Seats Dam is more than one mile from known plantings, and is presumed to have developed from seeds carried on vehicle tires as Viridian employees travelled from the airport fields to go swimming at the dam. One plant occurred in this site in 2006, four plants in 2007 and 156 plants in 2008 (91 seedlings, 65 flowering plants). All plants were manually removed at the time of their discovery, and specific locations of infested areas were documented.

The variety of habitats and locations infested by *Alyssum* is increasing. Currently occupied habitats range from gravel shoulders along Highway 199 (Figure 7), to ditchline and disturbed areas at Seats Dam, a popular local recreation site (Figure 8), to gravelly roadside traversing serpentine (Figure 4) to completely undisturbed native plant community hundreds of feet from any trail or road (Figure 9).

Table 1. Locations of *Alyssum murale* outside of cultivated fields, within the vicinity of the Illinois Valley Airport and Lone Mountain Road plantings.

			Year monitored		
Location	Ownership	Year discovered	2006	2007	2008
Seats Dam	USFS	2006	1	4	156
Hwy 199 RR Bridge S. To MP 35	ODOT	2006	2	2	6
Hwy 199 across from R & R Bot. Wayside	ODOT	2007	na	1	5
BLM *L. cookii* site	BLM	2008	na	na	5
Lone Mt./Wimer Rd.	USFS	2008	na	na	219
R &R State Wayside	State	2008	na	na	1
BLM Ditchline Rd.	BLM	2008	na	na	1
BLM Powerline Jeep Trail	BLM	2008	na	na	1
Yearly Totals (All Sites)			**3**	**7**	**394**

Although a collection of *A. murale* made in 1963 (from a garden in Benton County) is stored in the OSU Herbarium, this species has not been considered a component of the Oregon flora. However, this weedy mustard is included as "an escape from cultivation" in the Canadian flora (Mulligan 2002), and has been collected several times since 1981 from a "well-established, spreading population" in Colorado (Colorado Univeristy Museum 2003). No information regarding the source of the plants, or the nature of the soils (i.e. serpentine) where they were collected is available. Although the unique edaphic conditions characteristic of serpentine plant communities generally protect them from invasion by weeds, vigorous, well-adapted perennials such as *A. murale* and *A. corsicum* have the potential to establish themselves on southern Oregon's nickel-rich soils as easily as on the serpentine of their native habitats.

Figure 7. Bob Meinke (ODA) approaches one of five flowering *A. murale* plants growing along Highway 199 directly across from the state Rough and Ready Botanical Wayside in 2008. One plant was removed by ODA staff from this same location in 2007. (Photo by M. Jules.)

Figure 8. Maureen Jules (USFS) points at seedlings growing next to flowering *A. murale* near Seats Dam in Rogue River-Siskiyou National Forest. Seats Dam is a popular recreation site for day use, camping and OHV activity for both tourists and local residents. This year 91 seedlings and 65 flowering plants were removed from the site. (Photo by K. French.)

Figure 9. *A. murale* growing within an undisturbed plant community hundreds of feet from a trail or road within the Rough and Ready Area of Critical Environmental Concern. A total of five plants were discovered and removed from this site in 2008. (Photo by K. French.)

Existing cultivated plantings

The locations of nine cultivated plantings, including those at the Illinois Valley Airport, are currently known. The documented escape and proliferation of plants from the airport fields suggests that plants from the additional eight fields also have the potential to escape, and observations by citizens and USFS staff in 2006-2008 confirm the presence of plants outside cultivated field boundaries (Figure 10). The planting which poses the greatest risk of spread onto public land is located at Sauer's Flat immediately adjacent to the Illinois River. Plants in this site have been allowed to set seed for crop development research, and the potential for seed from this site to enter the Illinois River, be deposited along the Wild and Scenic Corridor, and eventually pass into the Kalmiopsis Wilderness makes this site especially problematic. Plantings at Lone Mountain Road and Westside Road also pose concern due to their proximity to vast tracks of USFS managed land containing serpentine soils (Josephine ophiolites). Seed from fields at Happy Camp Road could spread via Elder Creek which drains into the East Fork of the Illinois River.

Figure 10. A crop of *Alyssum corsicum* on private property abuts the south side of Airport Drive. Orange arrow indicates a satellite population of *Alyssum* which appears to be growing along the ditchline. The ditch originates at Seats Dam on National Forest land where the first *A. murale* infestation was detected in 2006. To date surveys show the ditchline is clean from Seats Dam to the Airport property. *Alyssum* may be spreading in the ditch from the airport property onto private land. (Photo by M. Jules.)

In 2008, Josephine County Commission made a decision to discontinue the County's lease with Viridian, and asked the company to remove plants from the site (A. Grossi, Illinois Valley Airport Director, personal communication, June 26, 2008). In early summer of 2008, fields at the airport were sprayed by Viridian employees. However, as determined by Ken French (Oregon Department of Agriculture), this glyphosate treatment achieved less than 10% mortality of *A. corsicum* and *A. murale* in this site (Figure 11). Although the plants were mowed following the herbicide treatment, a high percentage of the 50 acre crop will produce mature seed this year. An application of the herbicide Garlon at The Nature Conservancy's site achieved greater control, but many rosettes, especially of *A. corsicum*, survived the treatment. (Due to leaf texture and growth form, *A. corsicum* may prove more difficult to kill than *A. murale*.) Because data on seed longevity are not available for either *Alyssum* species, annual monitoring of the airport fields for emerging

Figure 11. Approximately one month after the 2008 glyphosate treatment, few plants are dead (orange arrow). Some (blue arrow) exhibit sub-lethal effects, while the majority appear unaffected by the herbicide treatment. Mowing occurred following herbicide treatment; mowing is not expected to prevent seed set in 2008. (Photo by M. Jules.)

seedlings - with herbicide treatment when needed - will be necessary until plants are eliminated from this site.

Current status

Bales placed at the airport from 2004 through 2007 have not been removed, and processing of material from any site had not occurred as of 2007 (Mark Weist, Viridian Resources, personal communication, 2007). Seed released from bales is viable, and numerous seedlings appear throughout the storage areas (Figure 12). Despite mowing of some portions of the airport site in 2008, large amounts of seed continue to be produced and dispersed from plants within field boundaries, as well as outliers throughout the area.

Figure 12. These bales of *Alyssum*, harvested over a period of several years, and awaiting processing at the airport site, harbor viable seed. Roadside infestations of this species were probably caused by seed spread during transport of bales to this site, or by seed carried on the wheels of equipment moving among cultivated fields. (Photo by M. Jules.)

The status of cultivated sites other than the airport is not known. Information on Illinois Valley farmers currently growing *Alyssum* under contract with Viridian Resources was provided by Mark Weist (Viridian Resources) in 2006-2008. A compilation of this information was prepared by Maureen Jules (Rogue River-Siskiyou National Forest) in 2008, including ownership and location data for nine sites currently under cultivation, including the Illinois Valley Airport. Flowering plants in fields were reported by USFS staff and/or local citizens at four of the five sites observed, and escaped plants at two. (Four sites were not located.) Other cultivated sites may exist, as a complete list of leasees has not been acquired from Viridian Resources. One additional site was purchased by The Nature Conservancy (TNC) in 2003 with an existing lease with Viridian Resources. TNC initially allowed continued cultivation of plants, but terminated the lease agreement in 2005 (Molly Sullivan, TNC, personal communication, October 2006). Despite ongoing efforts by TNC to eradicate *Alyssum* from this site, plants of both species continue to persist, and an escaped plant was removed from an area adjacent to the field in 2007 (Kyle Strauss, TNC, personal communication, June 2008).

In 2007, the Good Earth Organics soil company began a compost operation adjacent to the Illinois Valley Airport. Compost is stored at this location, and this retail operation sells soil for use throughout the valley. *Alyssum* grows in the fenceline next to property used by Good Earth Organics (Figure 12), and cut inflorescences with mature seed have a high chance of blowing from the fields onto the soil company site. Seed dispersal into this area potentially allows for the spread of contaminated soils into other suitable serpentine habitat throughout the county.

Figure 12. Flowering plants of *Alyssum* adjacent to the Good Earth Organics soil company. (Photo by K. French.)

Livestock toxicity

Hyperaccumulators are highly toxic, containing concentrations of their target metals far in excess of levels considered toxic to cattle, sheep, swine and chickens, often by orders of magnitude (Angle and Linacre 2005, Table 2). Although no data on the palatability of *Alyssum* species to livestock or wildlife is available, the high alkaloid and metal content characteristic of hyperaccumulators probably limits the attractiveness of these species as forage. However, the ingestion of even moderate amounts of *Alyssum*, as might occur in cattle confined in an infested field, would probably result in livestock poisoning. Wildlife might also resort to using *Alyssum* as forage under some conditions, and small herbivores might ingest seeds or flowers. The likelihood and expected results of ingestion of these plants by wildlife is not known.

Table 2. Metal concentrations for "typical" agronomic plants, phytotoxic metal concentrations in plants, metal concentrations used for delineation of hyperaccumulators, and maximum metal concentrations tolerated by livestock. *Alyssum murale* and *A. corsicum* are hyperaccumulators of nickel (highlighted in yellow).

				Max. conc. tolerated by animals mg kg^{-1} in diet		
Metal	Plant avg. mg kg^{-1}	Phytotoxicity mg kg^{-1}	Hyperacc mg kg^{-1}	Cattle	Sheep	Chicken
Cd	0.1-1	5-700	>1000	0.5	0.5	0.5
Cu	3-20	25-40	>10,000	100	25	300
Mn	15-150	400-2000	>10,000	1000	400	2000
Ni	0.1-5	50-100	>10,000	50	100	300
Zn	15-150	500-1500	>10,000	300	1000	1000

(from Angle and Linacre 2005)

Assessing Pest Risk

Assessing Pest Risk: Two weed rating systems were used for this weed risk assessment. The first is a modified rating system adapted from the Weed Risk Assessment Guidelines for Qualitative Assessment developed by the United States Department of Agriculture, Animal and Plant Health Inspection Services, Plant Protection and Quarantine (USDA-APHIS 2002). A second system, Oregon Department of Agriculture's Noxious Weed Rating System, is also used.

ODA Modified USDA - Qualitative Risk Assessment

Common Name: *yellowtuft* **Scientific Name:** *Alyssum murale and A. corsicum*

(Intermediate scoring may be used e.g. =4)

The Oregon Department of Agriculture -USDA modified risk assessment identifies several dominant factors that influence plant establishment, reproduction, dispersal and impacts, then applies numerical value to these factors. The choices taken by reviewers on each topic can often be very subjective and variable based on the knowledge, observations and experience of the reviewer. Every effort was made by the authors to be inclusive in the descriptions as reasonably possible with the expectation that some weeds will not fit well in every category. It is intended that the risk assessment serve as a logical process for governmental agencies and weed control professionals for listing plant species as weeds and to help prioritize target species for control.

1. **Habitat Availability**: Does habitat availability restrict a plant's ability to survive and establish in the analysis area? How much susceptible habitat is available and are there physical or environmental factors that would favor or restrict the ability of the plant to thrive in the available habitats in Oregon? If plant is parasitic, do suitable host plants exist for establishment?

- Low (1) Susceptible habitat is very limited usually restricted to a small watershed or part of a watershed. Plant is severely confined by certain soil types, moisture holding capacity, competing vegetation, human intervention.
- Medium (3) Susceptible habitat encompasses 1/4 or less of the analysis area. Plant only moderately confined by environmental factors such as certain soil types, moisture holding capacity, competing vegetation, human intervention.
- High (5) Susceptible habitat is enormous covering large regions or multiple counties in the analysis area *or* limited to a restricted habitat of high economic/ecological value. Plant may demonstrate great adaptability to a variety of environmental conditions.

Score: 3

Explanation: These two *Alyssum* species are restricted to serpentine soils, which occur sporadically throughout the Illinois Valley in Josephine and Curry County. Smaller areas of serpentine soil also occur in Douglas and Jackson County, and large areas in California. These areas are unique and are of high ecological value.

2. **Dispersal Potential after Establishment: *Natural* Dispersal Factors.**

- Negligible (0) Plant has no potential for natural spread in the analysis area.
- Low (1) Plant has potential for *local* spread within a year. Moderate reproductive potential or some mobility of propagules. Animals may move propagules locally, also wind and wave action in lakes.
- Medium (3) Plant has a moderate potential for natural spread with *either* high reproductive potential *or* highly mobile propagules. Propagules spread by moving water or animals.
- High (5) Plant has potential for rapid natural spread throughout its susceptible range. Has high reproductive potential and highly mobile propagules. (e.g. Seeds can be wind dispersed over long distance.)

Score: 4

Explanation: Both species produce large amounts of viable seed, and can be spread by wind or potentially by water.

3. **Economic Impact:**

Should consider human health and livestock losses in the HIGH section.

- Negligible (0) Plant causes none of the above impacts.
- Low (1) Plant has potential to cause or demonstrates moderate to low potential impacts throughout analysis area in one or few of the above categories.
- Medium (2) Plant has *potential* to cause or *demonstrates* moderate impacts in few of the above economic categories or moderate to low impacts over a wide range (over 5 types) of economic plants, recreation, products or livestock throughout analysis area.
- High (5) Plant has *potential* to cause or *demonstrates significant* impacts throughout analysis area resulting in reduced crop yield, lowered commodity value, increased cost of production or a loss of markets due to contamination *or* weed also may cause high (larger) financial impacts to recreation, livestock losses, fishing and hunting and property values. Control costs to manage infestations would become significant. Plant directly linked to human health concerns (e.g. poisoning, burns or contribute to increases in vertebrate or invertebrate pests which serve as infectious disease carriers).

Score: 3

Explanation: Both species are poisonous to livestock and wildlife although probably would not be a preferred food source. Loss of unique natural resource (serpentine flora) would negatively affect tourism.

4. **Environmental Impact**:

Causes impacts on ecosystem processes; causes changes in plant community composition; in plant community structure and function; causes indirect impacts that are measured by a reduction in aesthetic value, reduced opportunities for recreation and reductions in other non-monetary values.

- Negligible (0) None of the above impacts probable.
- Low (1) Plant has *potential* to cause, or *demonstrates* few or minor environmental impacts throughout analysis area or impacts occur in degraded or highly disturbed habitats.
- Medium (2) Plant has *potential* to cause, or *demonstrates* moderate impacts throughout analysis area or impacts occur in less critical habitats.
- High (5) Plant has *potential* to cause, or *demonstrates* significant impacts in several of the above categories. Or plant causes impacts in select *priorit*y habitats such as aquatic, riparian, salt marsh, T&E plant sites and other sites deemed critical.

Score: 5

Explanation: *Alyssum* species have the potential to outcompete unique native flora on serpentine substrate. Two federally endangered species in immediate area.

5. **Likelihood of Introduction and Spread:**

Entry Potential: The likelihood that an exotic plant will be introduced and spread depends on the number of associated factors, some physical, some biological, some social/economic. For this analysis, consider the following five factors:

5a. **Weed is a Pest in Similar Climactic Zones**: (See attachment 1)

- 1= Plant is strictly limited to one minor climactic area or zone. Plants exhibit little adaptability to new environments or complete information is lacking on plant distribution in climate zones.
- 3= Plant demonstrates weedy characteristics in non-place of origin areas only. Plant limited to a few climactic zones.
- 5= Plant is known to be a significant pest in similar climactic zones at place of origin *or* demonstrates significant adaptation to multiple climactic zones wherever it is found.

Score: 4

Explanation: *Alyssum murale* is widespread in its native area, readily colonizing harsh sites, and tolerating extreme conditions. It is highly variable allowing for quick adaptation to varied (serpentine) environments.

5b. **Current Distribution:**

- 1= Plant widespread, occurs throughout the state with containment improbable or weedy populations mostly found in more distant US regions or foreign country only.
- 3= Plant regionally established (eastern/western Oregon) with eradication impossible, or weedy populations found in Western US regions but not *directly* adjacent to Oregon border.
- 6= Plant population limited to 1 or a few infestations in state or not known to occur but with weedy populations *directly* adjacent to Oregon border.

Score: 5

Explanation: These *Alyssum* species are just beginning to colonize natural sites. Infestations are small, and have been actively managed since discovery.

5c. **Probability of Detection at Introduction Point**:

- 1= Plants growing where probability of rapid detection high, plants showy, public easily recognizes plant, access not limited.
- 2= Plant easy to identify by weed professionals, ranchers, botanists, some survey and detection infrastructure in place.
- 3= Plant populations growing with high probability of no initial detection, plant shape and form obscure/not showy for much of growing season, introduction probable on lands remote or with limited access to weed professionals.

Score: 2

Explanation: Flowering plants of both species are easy to identify. Determining location of planted fields to allow for surveys of nearby areas has been difficult.

5d. **Probability of Weed Import or Movement to Suitable Habitat Through *Human* Activities**:

Does not consider transport by recreation, equipment and vehicles; you may choose to address that here.

- 1 = Low probability of introduction either naturally or by humans. Low probability of humans or animals contacting weed at point of origin.
- 2 = Moderate probability of introduction. Generally non-agricultural commerce, vehicles, equipment.
- 3 = High probability that weed will be introduced yearly via agriculture, commerce, commodities.

Score: 3

Explanation: This species is easily moved by vehicles. Transport of baled crop has resulted in roadside colonization.

5e. ***Environment*** **and Reproductive Potential:**

- 1= Environmental factors damage plant growth and/or prevent reproduction. Obligate pollinator not present.
- 2= Environmental factors restrict full growth and reproductive potential and plant is poorly or clearly not self-fertile.
- 5= Environment possesses ideal conditions for growth and reproduction. Plant expresses full growth and reproductive potential in environment. If dioecious then both sexes are present or plant is self-fertile.

Score: 5

Explanation: Both *Alyssum* species are specialist plants – the serpentine areas of Josephine County are the ideal environment for their growth and reproduction.

Score: Subtotal of 5 = 19

6. Current Distribution:

- 5= Not known to occur, or limited to 1 or a few infestations in state
- 3= Regionally abundant (eastern/western Oregon)
- 1=Widespread, occurs throughout the state

Score: 4

Explanation: Currently known from only eight relatively small infestations outside of planted areas.

The total assessment score for *Alyssum murale and A. corsicum* (out of a possible 46) with the modified USDA-APHIS Risk Assessment is:

38	34 - 41 "A" Weed	24 - 34 "B" Weed	Below 24: unlisted

Oregon Department of Agriculture
Noxious Weed Rating System

Common Name yellowtuft

Scientific Name *Alyssum murale and A. corsicum*

Points Category

1. 3 Detrimental Effects: Circle all that apply, enter number of circles

1. **Health:** causes poisoning or injury to humans or animals
2. **Competition:** strongly competitive with crops, forage, or native flora
3. **Host:** host of pathogens and/or pests of crops or forage
4. **Contamination:** causes economic loss as a contaminate in seeds and/or feeds
5. **Interference:** interferes with recreation, transportation, harvest, land value, or wildlife and livestock movement

2. 4 Reproduction & Capacity for Spread: Circle the number that best describes, enter number

1. Few seeds, not wind blown, spreads slowly
2. Many seeds, slow spread
3. Many seeds, spreads quickly by vehicles or animals
4. Windblown seed, or spreading rhizomes, or water borne
5. Many wind-blown seeds, high seed longevity, spreading rhizomes, perennials

3. 3 Difficulty to Control: Circle the number that best describes, enter number

1. Easily controlled with tillage or by competitive plants
2. Requires moderate control, tillage, competition or herbicides
3. Herbicides generally required, or intensive management practices
4. Intensive management generally gives marginal control
5. No management works well, spreading out of control

4. 5 Distribution: Circle the number that best describes, enter number

1. Widely distributed throughout the state in susceptible habitat
2. Regionally abundant in part of the state, 5 or more counties, more than 1/2 of a county
3. Abundant throughout 1- 4 counties, or 1/4 of a county, or several watersheds
4. Contained in only 1 watershed, or less than 5 square miles gross infestation
5. Isolated infestation less than 640 acres, more than 10 acres
6. Occurs in less than 10 acres, or not present, but imminent from adjacent state

5. 4 Ecological Impact: Circle the number that best describes, enter number

1. Occurs in most disturbed habitats with little competition
2. Occurs in disturbed habitats with competition
3. Invades undisturbed habitats and crowds out native species
4. Invades restricted habitats (i.e., riparian) and crowds out native species

TOTAL POINTS: 19

Note: Noxious weeds are those non-native plants with total scores of 11 points or higher. Any plants in 4.1, 4.2, and 4.3 should not be classified as "A" rated weeds. Ratings: 16 + = A, 15 – 11= B

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